

Problem-Solving Skills

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The initial steps in assessing problem-solving are obvious in that we need to identify what skills are to be assessed and what purpose will be served by the assessment. Once those objectives are identified, it becomes much easier to approach the task of assessing the problem-solving skills of our students.

The NDSU Libraries contain several reference materials that can assist us in developing the format that will work in individual classes and situations. The major reference for this discussion will be *Classroom Assessment Techniques - A Handbook for College Teachers*, 2nd ed., by Thomas A. Angelo and K. Patricia Cross. Major reasons for selecting this reference include its utility, the two copies in the library (Call no.: LB 2822.75 .A54 1993), and the numerous copies distributed across campus as a result of assessment workshops.

Problem-solving skills are included in the eight teaching goals listed by Angelo and Cross as *higher order thinking skills* (page 20). Once teaching goals are identified, we can progress to recognizing (and avoiding) potential pitfalls with an assessment activity (page 59). For example, we are advised to start small, build upon success, and be flexible and willing to change. One method of implementing this advice could be to introduce assessment techniques relatively early in the curriculum of any major and progress to more sophisticated assessment procedures in upper-division courses.

The second part of the Angelo and Cross (1993) reference identifies 50 classroom assessment techniques and provides discipline-based examples. The discussion of individual assessment techniques includes a summary of the amount of faculty time involved in preparation of the activity as well as the amount of student time involved in responding and of faculty time required for analysis. That information is summarized below.

As an example, the widely utilized assessment technique of the "Background Knowledge Probe" involves a moderate amount of faculty time in preparation and in evaluation but only a low amount of effort on the part of students. "Documented Problem Solutions" is one of the assessment techniques that is specific for problem-solving skills and has a low time requirement for preparation with moderate time requirements needed for student response and for faculty analysis.

A variety of assessment techniques that may be used for assessing problem-solving skills and other higher-order thinking skills (as listed by Angelo and Cross) are listed below. Each can be readily modified for use in a range of curricula. To determine which assessment technique to use for which course, review the "Pros," "Cons," and "Caveats" discussions at the end of each of the individual assessment techniques.

	Time required for:		
Assessment Technique:	Preparation	Student	Analysis

(Specific to problem-solving)		Response	
Problem recognition tasks	Medium	Low	Low
What's the principle?	Medium	Low	Low
Documented problem solutions	Low	Medium	Med.- High
Assessment Techniques Involving Other Higher-Order Thinking Skills:	Preparation	Student Response	Analysis
Minute paper	Low	Low	Low
Muddiest point	Low	Low	Low
Categorizing grid	Low	Low	Low
Defining features matrix	Medium	Low	Low
Pro and con grid	Low	Low	Low-Med
Analytic memo	High	High	High
Concept maps	Medium	Medium	Med- High
Applications cards	Low	Low-Med	Low-Med
Diagnostic learning logs	Medium	High	High
Quality circles	High	High	Med- High
"RSQC2"(Recall, Summarize, Question, Comment, Connect)	Low	Low-Med	Medium
A Broadly Applicable Assessment Technique:	Preparation	Student Response	Analysis
Background Knowledge Probe	Medium	Low	Low

One of the probable results of reviewing the assessment techniques outlined in Angelo and Cross is that many faculty will recognize that they have been utilizing some of these activities in their classes without being aware that the activities were named and had formal identification with assessment.

The assessment techniques discussed by Angelo and Cross should be considered to be examples that can be easily modified to a particular situation in individual classes. Similarly, a wide variety of additional resource materials are available that may provide starting points for the development of techniques tailored to individual classroom situations.

Our initial task is determining which problem-solving technique to use or adapt to our classrooms. Once that is accomplished, we should be in a position to document the

(increase in) skills of our students and to implement additional classroom methods of assisting our students in developing further problem-solving skills.

Problem Recognition Tasks

What is Problem Recognition? Examples of common problems are presented to students and they are expected to identify the basic type of problem represented by each example.

What is the purpose of Problem Recognition Tasks? Students often view problems as separate or distinct situations that share little common features. Recognition of problem types is the first step to solving the problem and increasing the student's experience in understanding the type of problem involved should increase the speed and accuracy with which subsequent problems are solved.

Faculty benefit by learning if students are correctly identifying types of problems. If students are incorrectly classifying the types of problems, corrective measures may be taken. The material to be presented in any course can be presented more efficiently and effectively when students quickly recognize the type of problem involved.

- Time required by faculty in preparation: Medium
- Time required by students to complete: Low
- Time required by faculty to analyze: Low

Using Problem Recognition Tasks: This assessment technique is particularly appropriate in quantitative and technical courses but may also be used to evaluate global problem-solving skills in the humanities and social sciences. Specific steps involved in developing a problem recognition task instrument include:

- Selecting examples that represent different (but related) problem types that are difficult for your students to differentiate. Each individual example should represent only one type of problem type.
- Determine if the students will be asked to match the examples to a list of problem types or if they will be asked to name the problem type without the aid of a list of problem types.
- Test your examples using colleagues, graduate students, or advanced undergraduate students. Information gained from testing can include if the examples are appropriate, the amount of time needed to complete the instrument, and the level of difficulty for students.
- Allow students more time to complete the problem recognition tasks than was required by faculty, graduate students, and advanced undergraduates.

The enhancement of student knowledge produced by your course can be evaluated or assessed by administering comparable problem recognition tasks at the beginning of the semester and at mid-semester or near the end of the term.

What's the Principle

What is What's the Principle: This assessment technique logically follows Problem Recognition Tasks in that once a type of problem is correctly identified, students must identify which of the principles involved in the class must be applied to solve the problem.

What is the purpose of the What's the Principle technique? One goal of What's the Principle is to assist students in understanding which general types of problems can be solved with the individual principles involved in the class. This technique can also be used to help students understand why problems may be encountered when basic principles are violated.

Using What's the Principle: This technique can readily be applied in any course where students are expected to learn precise (or imprecise) rules or principles. What's the Principle tasks may be applied with equal effectiveness in the humanities and social sciences as well as traditional science and technology subjects.

- Identify the basic principles that the students are (or will be) expected to learn. For assessments given after the first few class periods of a term, concentrate only on those principles presented in class to that time.
- Create examples that demonstrate the application of each of these principles.
- Develop a What's the Principle assessment tool that may ask students to match a list of examples with a list of principles *or* asks students to identify the principle(s) appropriate to the example without the aid of a list from which principles may be selected.
- Test the What's the Principle assessment instrument on colleagues, graduate students, and/or advanced undergraduate students.
- Make any modifications necessary on the assessment tool and utilize in your classroom.

Administering comparable What's the Principle instruments over the course of an academic term permits the evaluation of the enhancement of student learning in problem recognition and in the selection of principles appropriate for solving various problems.

Documented Problem Solutions

What are Documented Problem Solutions? This technique asks students to keep track of the steps involved in solving particular types of problems. Faculty gain an awareness of the steps utilized by the students in solving problems.

What is the purpose of Documented Solutions? This technique lets faculty understand how students approach problems as well as understand how students comprehend and describe problem-solving procedures. The writing component of this assessment technique may be useful for other purposes in the class.

- Time required by faculty in preparation: Low
- Time required by students to complete: Medium
- Time required by faculty to analyze: Medium to high

Using Documented Problem Solutions: Angelo and Cross (1993) state that this technique is extremely useful in subjects that involve mathematical or numerical processing and analysis. It is also very useful in any field involving structured methods of problem solving. Examples cited ranged from logic to law, chemistry, grammar, and music theory.

- Select up to three problems representative of those presented in class recently. If selecting three problems, one should be easily solved by the class while one should challenge the majority of the students.
- Solve each problem and determine the amount of time needed. Revise any problems that may consume too much time or be too complicated for the class.
- Develop clear-cut instructions for the class and recognize that the students will need more time for this task than was required by yourself or your colleagues asked to evaluate your assignment.
- Prepare the students for this activity and assure them that this is not a graded exercise. Emphasize that you are as interested in how they approach a problem as in obtaining a correct answer and that this activity will help them (and you) analyze their problem-solving skills.

Audio- and Video-Taped Protocols

What are Audio- and Video-taped Solutions? This technique is one of the most formal procedures available and has the potential restriction of being very time-consuming. However, faculty and students each receive an abundance of information. Video-taping can provide the greatest amount of information, some of which may be used for research

What is the purpose of Audio- and Video-taped Protocols? A major product of this technique is providing students with an awareness of their problem solving techniques. From this information, students can more readily understand how their analytical skills may be enhanced, if necessary. Audio- or video-tapes provide faculty with rich detail

about their students and their approaches to solving problems. Recording group or team sessions may be particularly helpful.

- Time required by faculty in preparation: High
- Time required by students to complete: High
- Time required by faculty to analyze: High

Using Audio- and Video-taped Protocols: Classes of small to moderate size are appropriate for this technique because of the amount of time involved. Because of the time factor, it may be desirable to apply this procedure to small groups of students working as a team or as individuals. Specific suggestions for applying this assessment tool include:

- Select a discrete problem where "show and tell" or "talking through" the problem will apply. Determine if the problem will be audio-taped or video-taped.
- Determine how the information gathered will be analyzed and arrange for the necessary equipment and facilities.
- Develop the problem(s) and establish clear guidelines and time limits. Guidelines for individual participation may be necessary for group or team projects.
- Establish a clear time-frame about the type and amount of information the students can expect as feedback.

This classroom assessment technique has essentially no limits on areas of applicability. It is particularly well suited in areas where individual performance or ability to function as part of a team is important. Examples range from music, speech, and health sciences to traditional sciences, engineering, and technology.

Using the Background Knowledge Probe

What is a Background Knowledge Probe? Background knowledge probes are extensions of the questionnaires that are often used on the first day of class. By extending the questions to examine their knowledge of the subject as the students enter the class, faculty learn the most appropriate level to begin the material for the class or for any given section. The format may be that of identifying correct responses (multiple choice or circling answers), writing short responses, making basic calculations, or a combination of response methods.

What purposes can be served by using a Background Knowledge Probe?

Background knowledge probes are useful as a stand-alone method to determine the most appropriate level to begin instruction in any class. When background knowledge probes are given near the beginning of a class and again at the end of a term, faculty have documentation about the extent of learning accomplished by the students. This information may be utilized in a variety of ways, including inclusion in departmental assessment reports.

- Time required by faculty in preparation: Medium
- Time required by students to complete: Low
- Time required by faculty to analyze: Medium

Using Background Knowledge Probes: Background knowledge probes are appropriate for use in classes of any size. Background knowledge probes may be used as a means of indicating to students what material is considered to be of greatest significance in the course. Specific comments about the application of this assessment technique include:

- Include at least one major point that students can be expected to know, at least in part. Use other questions to help the students understand what they will be expected to know by the end of the section of material or at the completion of the course.
- Prepare a variety of questions, each of which is carefully constructed to avoid testing vocabulary in the subject and subsequently confounding the results.
- Have the probe prepared in advance of the class period and incorporate the suggestions of other faculty, particularly if the course is part of a sequence.
- Inform the class about how the results will be utilized and reassure them that the results do not influence their grades. Unsigned responses may be used but the class should receive some feedback so they understand how they compare to their classmates in preparation. Identify how the results will influence how you will teach the course.

Reference

Angelo, Thomas A., and K. Patricia Cross. (1993). *Classroom Assessment Techniques - A Handbook for College Teachers* (2nd ed.). San Francisco: Jossey-Bass. NDSU Library Call Number: LB